

Annexure M: SAAGA maximum maturity guidelines

AVOCADO FRUIT MAXIMUM MATURITY GUIDELINES

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Introduction

Avocado fruit does not ripen on the tree. The ripening process only starts after the fruit has been picked. However, the fruit must reach a certain level of maturity on the tree before it will ripen properly. Fruit picked before this minimum level of maturity is reached will not ripen at all or will ripen unevenly, shrivel and/or have a rubbery texture. At the minimum level of maturity, although the fruit ripens properly, it is often bland with a watery texture, but as the fruit matures and oil content increases, the fruit becomes “creamier”.

Less mature fruit is more susceptible to chilling injury (‘cold damage’) during refrigerated storage. Export shipping temperatures are adjusted accordingly.

Ripening time becomes shorter as maturity increases. At minimum maturity, an avocado may take up to 2 weeks to ripen at room temperature, whereas a mature fruit will ripen in a few days.

As the season progresses and the fruit becomes more mature, there is a risk of internal disorders such as grey pulp developing, especially after weeks under refrigeration en route to export markets.

Fruit maturity is most commonly determined by the fruit dry matter content. Traditionally, South African regulations stipulated minimum maturity as percentage moisture content. This was changed in 2018 to bring the South African standards in line with the international convention of using fruit dry matter. Avocado fruit pulp dry matter is the reciprocal of the moisture content. Therefore, a fruit moisture content of 80% is equivalent to a dry matter content of 20% ($100 - 80 = 20$).

This document provides guidelines for maximum fruit maturity based on orchard and climatic conditions which predispose the fruit to physiological disorders such as grey pulp. **Section 1** deals with determining harvest cut off points based on fruit dry matter content and orchard conditions. **Section 2** incorporates fruit mineral analysis which allows for more accurate prediction of post-harvest problems and optimal picking windows to ensure good quality fruit.

SECTION 1

Determining harvesting cut off points based on dry matter content and orchard conditions.

Guidelines for maximum maturity levels for Fuerte, Hass, Ryan and Pinkerton were formulated in the early 2000s and are still valid. In addition to cultivar and maturity, factors such as crop load, climatic and soil conditions influence fruit’s susceptibility to internal disorders. Consequently, maturity at which these disorders appear will differ from orchard to orchard.

NB: If trees are under water stress, fruit dry matter will not give an accurate indication of fruit maturity, as the dry matter content is calculated as a percentage of the fresh mass. When a tree is water stressed, there will be less water in the fruit resulting in an elevated dry matter reading. When fruit is picked for moisture testing, tensiometer readings should not exceed -45 kPa.

High risk orchards are those orchards where soil and climatic conditions are conducive to vigorous vegetative growth, e.g. orchards in warm areas on land previously under bananas. Soils with a high

organic matter content will increase the risk of fruit disorders such as grey pulp. Fruit from dryland orchards can also be a higher risk.

Low risk orchards are those orchards where climatic and soil conditions are such that trees do not display excessive vegetative growth.

Low risk seasons are seasons where there is generally a heavy crop ("on year"). **High risk seasons** are when there is generally a light crop ("off year").

Table 1: Maturity cut off points (% fruit dry matter) (adapted from Kruger *et al.*, 2004).

	Low risk orchard		High risk orchard	
	Low risk season	High risk season	Low risk season	High risk season
Fuerte	32	27	26	24
Pinkerton	30	27	25	23
Edranol	29	26	26	24
Hass	35	30	29	27
Ryan	35	31	28	27

Notes:

- Avocados with a dry matter content higher than the value indicated in Table 1 are at risk of developing internal disorders such as grey pulp and should not be exported under regular atmosphere.
- ***If controlled atmosphere CA or SmartfreshTM is used the maximum maturity guidelines can be extended by 3% for small fruit and 1% for big fruit.***
- The maximum maturity parameters given in Table 1 are conservative figures based on research conducted by the ARC.

Table 2: Risk factors that affect fruit quality (Kruger *et al.*, 2004)

Factor	Higher risk	Lower risk
<i>Maturity</i>	More mature	Less mature
Maturation rate	Faster	Slower
<i>N fertilizer</i>	More & organic	Less & inorganic
Soil type	Higher potential	Lower potential
Orchard temp	Warmer	Cooler
Rainfall	Rainy season	Dry season
Tree age	Younger trees	Older trees
Fruit load	Off year	On year
Fruit size	Large fruit	Small fruit
Storage temp	Lower	Higher
Storage condition	RA only	CA/Smartfresh
Storage period	Longer	Shorter

Fruit dry matter contents coupled with fruit Nitrogen content are the best indicators are post-harvest quality (incidence of physiological disorders).

See ANNEXURE 1 for decision trees based on Tables 1 & 2 and fruit nitrogen levels.

SECTION 2

Determining optimal harvest windows based on fruit dry matter, mineral content and orchard conditions

Fruit Sampling Procedure

The correct sampling procedure is crucial for accurate information regarding an orchard's fruit mineral and dry matter contents. Dry matter content coupled with fruit mineral content values will provide an indication of the optimal period for harvesting good fruit quality in a specific orchard. Trees from which fruit is sampled should not be water stressed and should preferably be irrigated 1-2 days before sampling. When fruit is picked for dry matter testing, tensiometer readings should **not be exceed 45 kPa**. A sample of ± 20 fruit should be taken from each orchard (not larger than 3 ha). Fruit should be of a representative size for the specific orchard, and of approximately the same count size. No more than 2 fruit from the same tree should be picked for sampling. Fruit should be picked at shoulder height, and from four sides of the tree (North, East, South and West). Fruit should be picked from the inside and outside of the tree canopy. Samples should be labelled and traceable to the orchard where they were picked.

The sample should be used to determine:

- Average fruit weight (indicates average fruit size and aids with interpretation of nutrient analysis)
- Fruit dry matter content (indicates fruit maturity level and gives an early indication of the time harvesting can commence). Fruit dry matter should be analysed every 4 weeks until harvesting. Thereafter samples should be taken every fortnight to determine when to stop harvesting.
- Fruit mineral analysis should include nitrogen, calcium and iron.

Fruit Mineral Analysis

Minerals that are correlated with avocado fruit quality (internal and external) are nitrogen (N), calcium (Ca), and iron (Fe).

Excessive N levels in the fruit lead to:

1. Increased lenticel damage in the beginning of the picking season.
2. Increased incidence of external chilling injury ("black cold") in the beginning of the season.
3. Increased levels of grey pulp towards the latter part of the season.

Low Ca levels in the fruit lead to:

- Increased levels of grey pulp.
- Increased susceptibility to grey speckling (Fuerte) as a result of low orchard temperatures.
- Decreased shelf life throughout the season.

Low Fe levels in the fruit will lead to an increased incidence of external chilling injury ("black cold") in the beginning of the season.

Fruit mineral analysis when fruitlets weigh ± 50 g (November in Limpopo and Mpumalanga)

Fruitlets of approximately 50 g should be sampled and analysed. Results of this analysis provide an

indication of whether critical elements (N, Ca and Fe) are present in sufficient quantities to ensure good post-harvest quality. Nitrogen and Calcium levels can be altered by adjusting fertilizer applications accordingly e.g., more Ca can be applied to trees during December to improve fruit Ca levels. This increase will then be reflected in the January fruit analysis.

If N levels are already high or borderline according to the 50 g fruit analysis, no more N should be applied prior to harvest. If N must be applied, it should be applied in small amounts and over as long a period as possible.

Optimal mineral levels in fruit ± 50 g in size

Mineral	%	ppm
N	<1.6%	<16000ppm
Ca	>0.1%	>1000ppm
Fe	>0.008%	>80ppm

Optimal mineral levels in fruit sampled ± 8 weeks prior to minimum harvest maturity ("January sampling")

Mineral:	%	ppm
N	<1.0%	<10000ppm
Ca	>0.05%	>500ppm
Fe	>0.006%	>60ppm

The "January sampling" norms are for fruit sampled +/- 8 weeks before the minimum harvesting maturity and would correspond to the following times in different regions:

Levubu:	End of December – beginning of January
Tzaneen:	Mid -January – end of January
Kiepersol:	End of January – beginning of February
Nelspruit:	Beginning of February – mid-February
Northern KZN:	Mid-February – end of February
Southern KZN:	Beginning of March – Mid-March

Using fruit mineral content to determine harvesting window

Fruit with High N levels:

- Should not be harvested too early in the season due to its increased susceptibility to lenticel damage. Lenticel damage is worst at the beginning of the season.
- Should not be harvested too early in the season due to its increased susceptibility to external chilling injury (“Black cold damage”). Early season fruit is more susceptible to external chilling injury.
- Should not be harvested too late in the season due to the higher probability grey pulp. Susceptibility to grey pulp increases towards the end of the season.

Fruit with Low Ca levels:

- Should be marketed as soon as possible due to its higher probability of having a short shelf-life.
- Should not be harvested too late in the season due to its higher probability of getting grey pulp.
- Should not be harvested too late in the season due to the higher probability of Grey Speckling, especially where cold spells occur. Grey Speckling develops as a result of low orchard temperatures at which frost occurs.

Fruit with Low Fe levels:

Should not be harvested too early in the season due to its increased susceptibility to external chilling injury (“Black cold damage”).

Table 3: Guidelines for an optimal avocado “harvesting window” to ensure best quality fruit (using fruit mineral analyses at when fruitlets weigh ± 50 g in conjunction with fruit dry matter content just before/ at harvest

	BEGIN Harvesting (Minimum maturity)		END Harvesting (Maximum maturity)		
Mineral	Low risk	High risk	High risk	Medium risk	Low risk
N	<1%	>1%	>1.2%	1.0 – 1.2%	<1%
Fe	>60 ppm	<60 ppm	-	-	-
Ca	-	-	<400 ppm	400–500 ppm	>500 ppm
Cultivar	Minimum dry matter content		Maximum dry matter content		
Fuerte	20%	22%	24%	28%	33%
Pinkerton	20%	20%	23%	25%	27%
Hass	23%	25%	27%	31%	36%
Edranol	25%	27%	24%	26%	29%
Ryan	20%	22%	29%	32%	36%